

CAN TELE-COMMUNICATIONS REPLACE TRAVEL?

Many companies are expanding their use of tele-communications to replace some of their employees' business travel. The alternatives they are using include: (1) voice-only audio conferencing, (2) audio-graphic conferencing using a combination of voice, graphics, and freeze-frame video, (3) video conferencing using full-motion video, and (4) computer conferencing using typed messages. In this report we look at the pros and cons of substituting tele-communications for business travel, mainly for holding meetings but also possibly to replace commuting to the office. Some interesting things are happening!

INTERACTIVE Systems Corporation is a major supplier of software products based on the UNIX operating system. The company has developed an electronic mail system, a text editor, a programming work-station, and a micro-computer operating system for the 16-bit C8002 system from Onyx Systems, Inc. of San Jose, California.

The company licenses UNIX from Bell Laboratories, which licenses it freely but does not provide on-going support or training for it. The company has adapted the operating system to their own needs (which, in fact, is practical with UNIX), markets it and supports it, along with their other related software products.

The company's headquarters are in Santa Monica, California, where about 60 of its 80 employees work. The other 20

employees work around the U.S., in four sales offices, in two small research offices, or, in a few cases, in their own homes.

INTERACTIVE links all of its remote work sites together electronically, using the GTE Telenet network. Each site has an Onyx micro-computer, the company's software, peripherals, a modem, and access to the Telenet network. Each of these micro-computers has 500K bytes of memory and 20M bytes of Winchester disk storage, and costs the company about \$13,000.

While the employees at these several sites are remote from headquarters, they are not isolated. They keep in daily contact with their colleagues using the company's electronic mail system, via Telenet. In addition, the company holds technical meetings at various cities around the U.S. every few months for its remote senior technical staff members.

Within the past few years, INTERACTIVE has been able to attract and keep some key employees because it is able to accommodate 'alternative working arrangements.' For example, one employee who worked at headquarters decided to move to San Francisco, some 400 miles away. Because he was a senior company researcher who wanted to continue to work for them, the company decided it was possible to let him work out of his new home using one of the Onyx micros. (The company calls the combination of the Onyx computer, peripherals, and software their IDEA machine.)

In three other cases, the company has hired computer scientists to work on specific research projects of interest to the company. In each of these cases, the professionals preferred not to work at an existing company site. So the company lets them work out of their homes—in Massachusetts, Texas, and Colorado—using Idea machines.

In one of these cases, the amount of work expanded beyond the researcher's capacity. So he now works out of a small office near his home and has a staff of three working with him. This points out an important hiring consideration for the company. They only hire 'remote' employees who live in areas where other technical people live and work. Should their workloads increase, the company can establish offices and staff them at those locations.

So far, the company has only senior computer science researchers working out of their homes full-time. These people are self-motivated, self-sufficient, and need very little supervision—so there are no supervisory problems with them. The company does not foresee hiring other types of remote employees, due to the supervision problems they could present. However, the company does allow many of its other professional employees to work at home part-time using terminals connected to company computers at headquarters.

INTERACTIVE is pleased that use of its own products allows it to hire experts in the computer field without requiring them to re-locate to company offices. For these employees, the alternative working arrangements allow them greater working flexibility. And yet they still re-

main in daily contact with co-workers and do get together with their colleagues about five times a year at the company's technical meetings.

Aetna Life and Casualty

Aetna Life and Casualty, with headquarters in Hartford, Connecticut, is the largest investor-owned insurance company in the U.S., according to *Fortune Magazine*. Aetna has assets of over \$36 billion, annual revenues in excess of \$13 billion, and employs some 39,000 people around the United States. Aetna is also a partner in Satellite Business Systems, along with IBM and Comsat; SBS began offering satellite communication services early last year.

In 1979, Aetna decided to consider in-house video conferencing, because some 550 programmers in the systems department within the casualty insurance division were to be moved to a new building in Windsor, about ten miles away from headquarters and the users they served. These programmers asked Aetna to investigate the possibility of creating video conferencing facilities at each location so that they could more easily meet with their users and avoid the up-to-75-minute round trip between the two sites.

The project began in February 1979, when the systems personnel in the casualty division began keeping track of the number of meetings they held with those users who were to remain in the main building. They found that the meetings involved some 2,000 employees a month. Reducing some of the future travel time for such meetings through video conferencing appeared to be cost effective, so a design team was formed. The team included people from purchasing, the casualty group (both data processing and end users), corporate communications, facilities management, and corporate data processing.

The team designed two pairs of video conferencing rooms. Each video conferencing room has a trapezoid-shaped table with three chairs on each of the two longer sides. Embedded in the wall in front of the table are three 25-inch television color monitors, two sound speakers, two fixed television cameras, and one movable camera. Each of the two fixed cameras is focused on the participants on one side of the table. As par-

ticipants look at the two screens on the front wall, they see three participants in the other room on each of the screens, in full-motion video. The movable cameras are operated by one participant at each location to 'zoom in' on objects displayed on the table or certain participants, to display writing on a chalkless blackboard, or to present a wide-angle view of the room. There is also a fixed black and white camera mounted in the ceiling directly above a backlit transparency section on the table. It is used to present hardcopy materials, such as computer printouts, hand drawings, overhead projection foils, correspondence, and so on.

The room is also equipped with seven microphones, audio speakers, a wall phone (often used for conference calls with a third party), a facsimile machine, a chalkless blackboard, two clocks (one inside and one outside), and a red 'in use' light.

Aetna is making a few modifications requested by handicapped users. One change is an adjustable volume headset so that participants with hearing impairments can better hear the conversations. In order to eliminate audio feedback in each room, normal amplification is set lower than those with hearing difficulties find comfortable. The conference tables were originally designed to accommodate wheel chairs; Aetna is now lowering the wall phones for participants in wheel chairs also.

The rooms in Hartford and Windsor are connected by a coaxial cable, which Aetna leases from the telephone company. The cable provides six television channels, three per pair of rooms. All of the conference room clocks are synchronized, and the power for these clocks is transmitted over the coax cable.

The equipment in the rooms is turned on each morning at 7:30 and turned off each evening at 5:00. The few control buttons in the rooms are simple to use, so the conferences are run by the participants. Employees just walk in, sit down, and start their meetings, we were told.

Within the first seven months of operation, over 1500 video conferences were held, involving some 11,500 participants. Most of these meetings involved only two or three people at each site. The rooms are becoming so popular,

we were told, that reservations are needed several days in advance for use in the morning and early afternoon hours. Users call a central reservation number and reserve a pair of rooms for a specific 45-minute time period.

The people at Aetna made one strong recommendation on designing rooms for video conferencing—bring in an audio engineer at the very outset. This audio engineer should: (1) determine the sound patterns in the rooms, (2) indicate where microphones should be placed to balance sound waves, (3) design the layout of power and signal cables for least interference with each other and the participants, and (4) recommend how best to insulate the rooms from surrounding noise. Aetna used such an expert and they believe his recommendations have led to very comfortable rooms. Without proper acoustic design, extraneous noises fed through the audio speakers can become very annoying to participants.

Each room cost \$250,000 to construct and costs about \$19 an hour to operate. Aetna feels that these rooms have already paid for themselves by the amount of inter-site travel that they have replaced.

Now Aetna is decentralizing corporate operations even more, and video conferencing is to play an important role in these plans. For example, by 1984 Aetna expects to add fourteen more rooms in five new locations, forming a local loop around the Hartford area. The communication links will most likely consist of coaxial and fiber optics cables. Several of the rooms will be small, with only one television camera; these are designed for meetings with one or two people at each location.

In addition, by early next year, Aetna plans to have installed four national rooms—in Chicago, San Francisco, Dallas, and Hartford—connected by satellite communications using the SBS service. Aetna estimates that these national rooms will pay for themselves in 7-1/2 years if they reduce travel between the cities by only 10%. And the company sees these rooms giving the company new marketing opportunities. For example, specialists from headquarters will be able to talk with prospective clients or train field personnel via video conferences.

In all, Aetna sees video conferencing helping to increase employee productivity and reduce expenses associated with travel.

The scope of tele-communications

Today's tele-communications are a hybrid of computer and communication technologies that appear in many forms. Components include telephone, television, computers, cable, fibre optics, radio, satellites, and many other elements. Any information exchange, be it by voice, image, or data, that uses a communications network is tele-communications. Some of the newest and most promising combinations, such as those called tele-conferencing and tele-commuting, may dramatically change the way we do business.

Tele-conferencing attempts to eliminate the need for physical relocation of personnel to one common spot for information exchange. Defined as "three or more people communicating electronically from two or more locations," tele-conferencing presently offers four choices: audio conferencing, audio-graphic conferencing, video conferencing, and computer conferencing.

Audio conferencing is familiar to anyone who has participated in a telephone 'conference call.' It is voice communication between three or more people participating from multiple locations. It can be used through a variety of types of telephone equipment: by individuals each using the familiar telephone handset, or by large groups using special equipment that levels the voice volumes of all the people in the group, or by small groups using speaker-phones, or in specially equipped tele-conferencing rooms.

Audio-graphic conferencing combines audio transmissions with one or more additional telephone connections for graphic displays, facsimile transmission, or freeze-frame or slow-scan video. Signals from each of these 'graphic' technologies are capable of being sent over voice-grade circuits.

The terms freeze-frame and slow-scan are often used interchangeably, but there is a difference. Freeze-frame freezes a single frame from a video camera and then transmits that frame. With slow-scan, images are transmitted one after another at a rate of approximately one pic-

ture every 60 seconds. If storage is available at the receiving end, each transmitted frame can be stored until complete; otherwise the new picture 'wipes out' the old picture, a line at a time, top to bottom.

Video conferencing is the most expensive and most complex form of tele-conferencing. It uses a television image as well as sound at all sites for group-to-group meetings. Generally only two groups are involved at one time, although several highly publicized video conferences were held recently connecting twenty or more sites. In general, such multi-site meetings are for disseminating information quickly from (say) the headquarters to the field offices of a company; there is generally little or no two-way discussion. Spurred by the assumption that the closer a medium can come to face-to-face communication the better, video conferencing is attracting a lot of attention as a substitute for business travel and face-to-face meetings. We will discuss some findings on this matter later in this report.

Computer conferencing uses the computer to facilitate communications between people at (generally) scattered locations. The most familiar and common application is computer messaging—text entered into a computer terminal at one location is transmitted to one or more locations. Or the message is stored in one central computer which others can access. The messages can be viewed when received or they can be stored for later retrieval. Computer conferencing systems add a number of additional features to electronic message systems, such as keeping each participant up-to-date on messages sent since he or she last used the system, maintaining a transcript of the on-going 'conference,' providing voting capabilities, and so on.

Two questions currently being asked about the use of these technologies are: Can they be used to replace travel and commuting? And what changes in working, communicating, and managing habits do they require? The first question—whether tele-communications can replace travel—has been studied, and we will report some findings. We should mention, though, that some of the research studies that are cited seem to give inconsistent or even contradictory results. So there is a lot that is yet to be learned.

We are gathering information on the second question—changes in working, communicating, and managing habits—and will report on that subject in a future issue.

Tele-conferencing versus business travel

The upward spiraling cost of energy has severely impacted travel. Airline schedules have become less convenient due to air controller problems and the reduction in the number of flights; plane and ground transportation fares have increased; and hotel rates and meal costs continue to climb. If much travel is involved, these factors can greatly affect the expenses of an enterprise. And although it is difficult to eliminate the basic differences between meeting in person and meeting electronically, the need for alternatives is growing more urgent each day.

The following discussion is based mainly on two sources. One is a research paper by Kraemer, of the Public Policy Research Organization at the University of California's Irvine campus (Reference 1). The second is a book by Johansen, Vallee, and Spangler (Reference 2).

Kollen and Garwood (whose work is described in both Reference 1 and 2) point out that 75% of business travel is for the purpose of meetings, and that a median average of two hours is spent in transit for each two-hour meeting. Technology for electronic meetings already exists. And in light of increasing travel expenses and the loss of work hours consumed by travel, the lower proportionate costs for communications may encourage greater use of tele-conferencing.

Tele-conferencing offers the benefits of availability, convenience, and possible cost savings, which often compensate for the loss of face-to-face contact. Once audio, audio-graphic, video, or computer conferencing facilities are in place, long-distance meetings can be held on short notice and when required. Employees can hold review meetings with others at remote locations by picking up their telephones, or by using nearby computer terminals, or by walking down the hall to a tele-conferencing room. Business issues can be addressed as they arise, and the tendency to postpone decisions until a physical meeting can be arranged is reduced.

In Reference 5a it is noted that the most appropriate choices for electronic meetings are those that are low in conflict and where the participants know each other. Training, ad hoc problem solving, briefings, policy dissemination, and emergency meetings are prime candidates for tele-conferencing. Generally, tele-conferencing is not appropriate for sales calls, delicate negotiations, to replace tours, to sign documents, and so on.

Miller (Reference 6) describes the findings of a study within the Bell System. He reports that the activities in their meetings consisted of: presenting reports (11%), providing status (16%), sharing information (35%), convincing (9%), negotiating (8%), and solving conflicts (20%). Sixty percent of these meetings were intra-company. Miller believes that only 50% of these meetings could be replaced by tele-conferencing.

Once the decision to substitute communications for travel has been made, then there is the choice of which alternative would be most suitable.

Audio conferencing

The availability of audio conferencing facilities is increasing. At a recent audio conference in which we participated, over 80% of the participants had already used audio conferencing for business purposes, some quite extensively. Audio conferencing is the best known of the four alternatives we are discussing. Telephone operators can set up conference calls, some PBXs allow users to set up their own conference call connections, and electronic 'bridges' or switches (such as ones offered by the Darome Corporation of Danbury, Connecticut) are available for the express purpose of co-ordinating and monitoring conference calls. A bridge can be installed in-house and used with specially equipped tele-conferencing rooms, or it can be used as a service, with the supplier providing the technical knowledge and operations people.

A growing phenomenon is the creation of audio conferencing rooms in companies. A major consideration in the design of these rooms is the acoustics. To avoid acoustical problems inherent in audio conferencing, numerous authors and people we talked with recommend consulting

with a sound engineer when designing these rooms. As Acampora (Reference 5b) points out, the engineer's job is to overcome the three deadly 'Rs' of audio communication: *room noise* created by machines, such as air conditioners, or coming through walls, doors, or windows, *reverberation* caused by echos between parallel walls and reflection from objects, and *return squeal* caused by sound from loud-speakers being picked up by the microphones. Tele-conferencing rooms with one or more of these problems can be very unpleasant to use.

Perhaps the most difficult problem in conducting an audio conference is the issue of speaking order. Visual clues are no longer available to determine who speaks when, so it is difficult to establish the speaking order—and sometimes even to identify who is speaking. Vendors have addressed the first problem by designing 'voice-switched' half-duplex systems. These are designed to capture only the dominant or loudest voice, and only the microphone in control can be transmitting. This can be annoying at times, for a cough or a sneeze grabs the microphone as easily as a spoken word. It can also discourage group spontaneity. Speakers continue to 'keep the floor' as long as they are talking or until they are interrupted by a louder voice.

An alternative to voice-switched half-duplex systems are 'open' full-duplex systems which allow everyone to speak at once. This type of system is more flexible, but it leaves the question of speaking order unresolved. At least one company, Telecom Australia, is experimenting with a multi-level, open system. Here the speaker is given a higher volume level than the other participants, but he or she can still be interrupted by others who activate buttons on their microphones. A micro-computer is used by the audio system to permit queueing of speakers waiting their turn, and the order is displayed on a lighted panel containing names of all participants.

In their book, *Electronic Meetings* (Reference 2), Johansen, Vallee, and Spangler state that audio conferencing is adequate for a number of typical business and research situations, particularly those which stress information exchange and problem solving. They found that the telephone is *not inferior*, in any simple sense, to

face-to-face meetings—it is generally judged by participants only slightly less satisfactory than such meetings. Audio conferencing is satisfactory for giving orders, making decisions, holding briefings, and simple problem solving. Audio conferences consume less time than do face-to-face meetings, and are most useful when conducted regularly. Participants may be more attentive to what is being said in an audio conference (although a speaker may not feel confident that remote participants are listening). And audio is effective for continuing contacts with people one already knows.

Many participants feel it is easier to get a point across, without a lengthy debate, in an audio conference than it would be in a face-to-face meeting. Further, participants have often felt that others are more persuasive and trustworthy in an audio rather than a face-to-face or video mode.

The weaknesses of audio conferencing are in areas of inter-personal communication, such as negotiations and getting to know someone. The authors point out that fewer words are spoken in a given time period via audio than video or face-to-face, and that audio conferencing groups tended to make fewer and less complex recommendations. Also, these meetings are more rigid and somewhat more tiring.

Miller believes that 50% of the meetings that can be held electronically can be held by audio or audio-graphic means.

Audio-graphic conferencing

Audio-graphic conferencing combines voice and slide-like images in a conference setting. It can enhance audio conferencing, as illustrated by its use at Hughes Missile Systems Group.

Hughes Missile Systems Group

Hughes Missile Systems Group is a division of Hughes Aircraft Company. The group builds guided missile systems for the U.S. and allied governments. Three of their largest programs are the Tow anti-tank system for the Army, the Phoenix air-to-air intercept system for the Navy, and the Maverick air-to-ground attack system for the Air Force.

The group employs over 7200 people at two sites. The design and engineering activities have almost 3300 employees, located in Canoga Park, California; the manufacturing division, along with engineering support, has some 4000 employees, and is located in Tucson, Arizona, roughly 500 miles away. This separation has caused numerous communication problems and much inter-site travel by employees.

Last year the group decided to create an audio-graphic conference room at each site. The two rooms cost a total of \$200,000 to install; installation was co-ordinated by Marcom Corporation of Scotts Valley, California. Each room can accommodate 20 people, and Hughes believes that the rooms will pay for themselves in one year if they replace just 4% of the 6000 trips made annually by employees between the two sites. The two rooms are linked by five conventional dial-up telephone circuits leased from Southern Pacific Communications Company. Hughes already had 26 leased lines connecting the two sites, so they use some of them for the conference rooms.

One voice-grade circuit is used for audio transmission. Each room contains three group microphones, placed down the center of a fifteen-foot long conference table and four speakers mounted under the table. These microphones and speakers are part of an audio conferencing system from Darome Corporation of Danbury, Connecticut. The system provides full-duplex audio, which the people at Hughes say is most important for providing 'real-life' conversations. With a half-duplex operation, using voice-switched microphones, the delay in switching from one voice to another can be very confusing to participants, they told us. Also, the Darome system features a 'howl suppression' circuit to reduce audio feedback. In addition, the floor, the ceiling, and at least two walls of each room have been sound-proofed to reduce the sources of noise interference.

A second voice-grade circuit is used for analog video transmission. Hughes uses a TVS 754 freeze-frame, black and white television system from Nippon Electric Company (NEC). The images from separate cameras are presented on two 23-inch television monitors mounted in a large cabinet at the front of each room. An 11-

inch TV 'preview' monitor and a control console are located near each conference table and used by a conference operator in each room to co-ordinate the sending and receiving of the video information.

Each room has three black and white cameras. One is a wide angle camera, generally used to view all of the participants in the room. A second camera has a zoom lens plus pan and tilt capabilities. It is used to focus in on the individual who is speaking and to view drawings mounted on the far wall. A third camera, and the one most heavily used, is mounted in the ceiling and focused on a lighted portion of the conference table. It is used to view transparencies, engineering drawings, photographs, test results, and small parts. It has a zoom lens so that remote participants can see details in (say) a six-inch section of the displayed article.

The NEC system takes a 'snapshot' of the scene which is first digitized and stored. Then this image is re-converted back to analog for transmission to the other site, where it is digitized, stored, and then displayed. A picture takes 37 seconds to transmit and display.

Hughes is considering upgrading to the newer NEC TVS 783 all-digital system when it creates new conference rooms at other sites. With the newer system, a color picture would take approximately 50 seconds to transmit, while black and white would take less than 20 seconds, over voice-grade circuits. Use of higher speed circuits would reduce the time still further. Faster transmission would add to the system's flexibility, we were told, especially at times when participants want to quickly refer to a different viewgraph or drawing.

A third voice-grade circuit is used for the electronic blackboard system that Hughes leases from the telephone company. Any marks made on one blackboard are displayed on a television monitor at the other site. Changes and additions to the drawing can be made from either blackboard. Each blackboard costs \$5000 a year to lease.

A fourth voice-grade circuit is used by the session operator at each site as a private communication line to co-ordinate the sending and receiving of the graphic information. These peo-

ple, from the group's sight and sound department, assist at all conferences in previewing and then displaying incoming pictures and previewing, adjusting, and then sending outgoing pictures. The pictures can be also be recorded on a video recorder for later recall.

The fifth voice-grade circuit is used to connect two high speed digital facsimile machines, also from NEC. The machines can transmit one page every twenty seconds and have automatic multiple page feed. The machines are not used heavily in tele-conferencing, but they do come in handy for printed material which cannot easily be seen on a television screen. They are located for general access outside the conference room and provide a popular self-service capability.

Each conference room also has two telephones for making calls to non-participants, when needed.

As the Hughes tele-conference co-ordinator mentioned to us, freeze-frame television works well for their particular use—that is, exchanging technical information rather than seeking personal reactions. Typically, each meeting starts with a 'snapshot' picture presented on a television monitor which shows the entire room, so that participants can identify who is at the other site. After that initial identification is made, participants are often interested in viewing the other participants only occasionally during the meeting. So for much of a meeting the two monitors may be used to display graphic information only.

For meetings where participants want to see and judge the non-verbal reactions of others, Hughes advises them to meet in person. So Hughes does not expect the system to replace a large percentage of the travel between the two sites. Also, any subjects of a sensitive or secure nature must be discussed in person, because the system does not have secure end-to-end communication links.

In all, the people at Hughes are pleased with the system. The operational costs are minimal, they feel, and the system does allow more employees to participate in more meetings with the other site, which enhances communications considerably.

Audio-graphics: An emerging alternative

Due to the perceived limitations of audio conferencing and the high costs of full-motion video conferencing, users and vendors alike are investigating a middle ground. There has been much excitement and numerous new product announcements in this middle ground area—which is now being widely known as 'audio-graphic conferencing.' The aim is to provide more than voice communication using standard voice-grade telephone circuits. Sometimes each additional graphic connection requires its own circuit, but there appears to be much work in the area of sending voice and data (both digitized) over one circuit.

The current graphic options are facsimile, electronic blackboards, electronic tablets, and slow-scan or freeze-frame television. The most interesting work appears to be in the television area.

Participating in an audio-graphic conference is much like sitting in a large conference room where you cannot see the speaker at the podium very well (perhaps the lights are dimmed). So you only hear the speaker's words and look at the slides being presented on a large screen. In audio-graphic conferences you hear a voice and see slide-like images. Perhaps some images may be 'snapshots' of the remote speaker, for identification purposes, but generally the visuals are slides, or displays of small objects, letters, or other documents.

Miller (Reference 6) notes that participants become less tired during audio-graphic conferences than during audio-only conferences, because they have visuals upon which to focus their attention. And, as with audio conferences, these conferences tend to be shorter than face-to-face meetings, perhaps because there are fewer side conversations.

Audio-graphic conferencing appears to be a promising area, and one worth watching.

Video conferencing

Video conferencing generally means using full-motion video between two or more sites. Full-motion video requires much wider bandwidth than the other tele-conferencing methods—about five megahertz per channel. Be-

cause of this requirement, most studies show full-motion video conferencing to be at a serious cost disadvantage to audio, audio-graphic, and computer conferencing. In fact, the only alternative with which video compares favorably is versus travel costs. Even here, the results are dependent upon the number of people involved, their locations, and the length and frequency of the meetings.

The costs of video conferencing are influenced by whether transmission will be by analog or digital signals. Analog systems have a lower equipment cost, but since each transmitted frame of the picture is a complete frame, the maximum amount of bandwidth is required. Digital systems have higher equipment costs because each frame is compared to the last one, and only the differences are transmitted. This lessens the amount of bandwidth needed.

Video proponents say that future technological developments, such as video compression techniques and efficient use of satellites, will eventually bring down the much higher costs of video conferencing.

Video conferencing is a group-to-group medium, typically with only two groups involved at one time. The video conferencing rooms are usually permanent, and often quite elegant. Public video conferencing facilities and services are also available. The Bell System provides their Picturephone Meeting Service in selected cities in the U.S. Numerous of the Holiday Inns now have facilities for conducting video conferences at their hotels. And we understand that similar services are becoming available in Australia, Canada, Great Britain, and Japan.

For complex communication situations, such as group discussions, Johansen, Valle, and Spangler found video superior to the other forms of tele-conferencing. They also found that new users accepted video conferencing more favorably. Further, they say, more complex solutions were presented by participants in video conferences.

The main issue questioned by researchers and users alike is whether full-motion video is really necessary during a tele-conference. Miller believes that only 20% of the meetings which can be held electronically require full-motion video.

He says participants need to see body language and facial expressions in these cases—yet some people we have talked with say these ‘visual cues’ rarely come through well in full-motion video.

A most interesting study on the differences between full-motion video and audio (including audio-graphic) conferencing was performed in the U.K. several years ago at University College London. That project gave rise to Communication Studies and Planning, Ltd. in London, and the following is based upon an article by Pye and Williams (Reference 3) that discusses the project’s findings.

Pye and Williams’ main conclusion is that video meetings are *not* more successful than audio ones, and they cite a number of studies that support their conclusion. They note that in several ‘laboratory’ studies, the participants who used audio changed their opinions more often than did those who used either video or face-to-face methods. And the medium used did not seem to influence participants’ opinions of each other. In another study of how effective these media were for ‘brain-storming,’ or coming up with new ideas, the authors concluded that the media did not affect the number of ideas generated, their originality, or their quality.

In the few ‘live’ studies that have been conducted, Pye and Williams found that *video is more like audio* than it is like face-to-face—which is contrary to what many people believe. The authors surmised that video is not ‘just like face-to-face’ and that non-verbal body language is not as crucial as many assume. They believe that many non-verbal and verbal ‘signals’ are often redundant. And when people cannot be seen, they shift to using verbal signals—they say, “I agree” rather than nod their heads. The authors believe that the major difference is ‘social presence’; in face-to-face meetings there is a feeling of closeness and contact that is reduced in any electronic meeting.

Pye and Williams also note that people *expect* video to be a markedly more effective meeting medium than audio, but, in fact, this preference becomes relatively unimportant when choosing between traveling and tele-conferencing. Participants apparently choose to travel or not depend-

ing upon the type of task, length of travel, and degree of acquaintance with the other participants. If the decision is to tele-conference, then the choice of which tele-conference medium to use is secondary.

Tasks which Pye and Williams say appear good for tele-conferencing are: giving and receiving information, asking questions, and exchanging opinions. Moderately successful uses are problem solving and generating ideas. Poor uses are for persuasion, bargaining, and getting to know someone. The authors cite a study in which Tyler, Cartwright, and Collins, using data developed by Pye and others, concluded that 45% of business face-to-face meetings could be replaced by audio conferencing, 8% could be replaced by video conferencing, and the remaining 47% would still require face-to-face meetings.

Pye and Williams also note that many participants expect a tele-conference to be less effective than a face-to-face meeting. Other proponents have expressed the opinion that, in the longer term, tele-conferencing will probably allow more meetings, which may be a more important consideration.

Computer conferencing

Computer conferencing has emerged as a real 'sleeper' in tele-communications. Although it has been available for several years, it has only been put into practice within the past couple of years. Casual access to terminals, convenient conferencing services, friendly text editors, and the unimportance of time zone differences are the major reasons for its increased use.

Computer conferencing is a medium that each participant uses only when he or she chooses. Users receive messages at their terminals each time they join (sign on to) the conference activity. Typically three to 25 people may be conferencing, though few confer simultaneously. The ability to join an activity when convenient is the most attractive feature of this form of meeting. Between conference sessions, a participant can research solutions, draft responses, and talk to another participant, without disrupting the main session.

The computer conferencing system provides a number of services. It keeps a complete record

of the discussion so that participants can retrieve comments easily. It can be instructed to poll participants on questions, keep track of who has voted and who has not, and then analyze the votes and report results to the session leader.

A major attraction of computer conferencing is its low cost. It can be less expensive than a telephone call. For example, the people at Infomedia in Palo Alto, California, who offer the Planet computer conferencing system, estimate that costs are about 25 cents per fifteen words, regardless of distance.

Computer conferencing is not suitable for some situations. For example, when a decision must be reached, a formal meeting which forces the participants to remain together until a decision has been made may be best. People cannot be forced to stay at a computer terminal in the same way. Also, since interactive communications using text is a new medium of 'conversing,' people are not likely to know proper etiquette. Experienced users report that they have seen major 'fights' occur over such systems—fights which had to be resolved verbally by the participants. Also, computer conferencing should not be used to entirely replace verbal conversations.

In a recent paper, Hiltz (Reference 7) evaluated the effect of the EIES computer conferencing system on users' other modes of communicating. The EIES system has been in operation since 1976 and has had more than 2,000 users and 200,000 hours of use since then. In her study, Hiltz wanted to know if its use (1) substituted for other modes of communication, (2) added on to other communications, or (3) expanded and stimulated travel, telephoning, mail, etc.

Hiltz found that computer conferencing initially was just an add-on to the use of mail and the telephone. but gradually became a substitution for these modes for most users. However, some (14%) did report that EIES stimulated more use of the telephone and the mail. She suggests this is because use of the system increases one's number of contacts, which increases the number of documents requested.

Hiltz found, somewhat surprisingly, that communication with co-located colleagues (those working within walking distance) *always* in-

creased, no matter how little one used the EIES system. And she concluded that only at high levels of use did the system impact other modes of communication—and more likely than not, it stimulated more use of these other modes.

Palme, in a 51-page report (Reference 8), discusses user experiences with the COM computerized conferencing system in Sweden, over a two-year period (mid-1979 to mid-1981). The largest body of users (70%) was from the Swedish National Defense Research Institute; most of the others were from universities and other research institutes. Based on user interviews, Palme concludes that most COM usage was *not* a replacement for existing communication methods; rather, it was used as a new medium. The typical regular user was connected for about 20 minutes per day, during which he/she read 22 messages and wrote one message.

The users of COM exhibited more information exchange among people at different organizational levels than is the case with conventional communication media. Further, Palme says, "This is most marked for non-bosses and for people aged less than 40 years." The system gives more people a chance to express their views and less likelihood of anyone's views being overlooked.

One can conclude from the above discussion that there is a lot of interest among researchers in the tele-conferencing area. In some cases, they have found that tele-conferencing can indeed replace travel effectively—but the researchers are not always in agreement on which uses are effective substitutes and which are not. Also, it remains to be seen what the longer term effects of such substitution will be. And many proponents note that substitution is really the least important aspect. New, unanticipated uses of electronic meetings may provide the really 'big pay-offs.'

Tele-commuting versus commuting

A related subject involves using tele-communications to replace commuting to and from the office every day—that is, tele-commuting.

Tele-commuting is the use of remote terminals to perform work from a satellite office or an employee's home. The feasibility of substituting

tele-commuting for commuting to a central location depends upon the type of work the employee performs. If the employee is engaged in the physical creation or movement of goods (such as in a factory or in a trucking firm), then tele-commuting clearly is not a viable alternative.

But categories of work that *are* suitable for this substitution include the activities of some types of managers, information analysts, computer professionals, and word processing operators. A growing percentage of people in both data and word processing are currently using computer terminals—so that re-locating their office hardware to their homes or satellite work sites in suburban areas would not present technical problems.

However, what must be considered prior to these technical problems are employee and employer attitudes, benefits and problems, advantages and disadvantages.

This subject area of attitudes, etc. is a large one and we will devote a near-future issue to it. For this discussion, we will just touch briefly on a few of the benefits and problems that tele-commuting can offer employees and employers.

Employees. Interest by employees in working at their homes, or at locations close to their homes, has increased due to both social and economic changes. Women with young children are now more a part of the labor force. Heavier automobile traffic and longer commuting distances have lengthened travel time to work. Automobile fuel prices have risen, as have the costs of public transportation.

Further, in the "seller's market" of data processing, experienced programmers, analysts, and system designers can select their employers with a keener eye toward job comfort and benefits.

It is in such an environment that some companies are finding it desirable to offer tele-commuting options to certain employees.

There is another side to this issue, however, as far as some employees are concerned. Some resist tele-commuting because, to them, the office is their outlet for social interaction. Some say they would miss the office politics and social conversations. Others feel that commuting to the

office helps them differentiate between their working and home lives; for instance, some who work at home in this way claim that they feel guilt when it is time to turn to home duties or relaxation, if they have uncompleted job tasks. These are only some of the possible negative aspects of tele-commuting, from employees' points of view.

Employers. A prime employer motive for considering alternate work sites is the soaring cost of real estate and energy. Expanding work facilities in metropolitan areas is expensive. Space in many business centers is at a premium, not only in price but in availability. And heat, air conditioning, lighting, maintenance, parking, and security are higher priced items in large urban facilities.

By opening additional offices at outlying locations, equipped with remote terminals (and perhaps computers) linked to a main data processing center, a company may realize substantial savings in rent and utilities. Installing terminals, and even micro-computers, in employee homes increases telephone charges but eliminates or greatly reduces many other office costs.

Whether employees realize it or not, most companies subsidize their commuting. For example, in New York City, employees work a 35-hour week, while paid for forty. Companies in metropolitan areas pay higher salaries, basically to subsidize commuting costs.

On the negative side, a main issue is the management and supervision of 'remote' workers. Tele-commuting can change long established patterns of management, simply because it reduces daily observations of employees. With workers at home or in multiple locations, methods of supervision must be re-defined and new ways to measure work will be needed, to replace 'hours at the office.'

So while we do not foresee employers rushing to offer tele-commuting, we do know of numerous companies investigating this area. We are currently investigating this subject and, as mentioned, we expect to report our findings in the near future.

Tele-communications security

Tele-conferencing and tele-commuting both raise a problem that many (most?) organizations have preferred to ignore—tele-communications security.

In his recent book, *Who, what, and where in communications security* (Reference 4), J. Michael Nye provides an interesting discussion of communications security concepts and current protection technologies. He also includes in this book a listing of security product offerings.

In the context of tele-communications, security refers to the act of restricting access and use to a defined group. The better the security, the higher the level of confidence that only members of the group have access to and use of the information being protected. Both the distance and the transmission media, such as radio waves or wires, contribute to the security (or lack of security) of a system—for instance, the longer the distance, the less secure a system is likely to be.

Security of tele-communications networks

Tele-communication networks are made up of some combination of land lines, microwave radio (both satellite and terrestrial), and undersea cables. In the United States, about 70% of all toll calls are carried over microwave radio signals *at some point* in their transmission. Although today there are some specialized systems designed for the transmission of data, most communication networks were designed to carry voice messages, where security was not an overriding issue. More than 90% of the communications volume processed by either private or public line services is handled by direct distance dialing systems, which automatically switch calls among links with varying levels of security, without regard for the possible interception of messages, states Nye.

There are three methods for unauthorized interception of messages: (1) through electro-magnetic emanations ('tempest'), (2) by detecting air-bound signals, and (3) by tapping phone lines. Tempest refers to the electro-magnetic radiations which leak from all electronic systems (such as word processing machines). The emissions may be intercepted and information ex-

tracted, but generally this is done only by highly skilled espionage groups.

Tempest and air-bound signals can be intercepted by passive monitoring, without doing anything to enable the message sender or receiver to be able to detect the interception. On the other hand, phone lines must be actively 'tapped'—that is, the intruder must attach monitoring equipment directly to the line—and such taps can be detected.

Satellite, radio wave, or microwave transmissions pose the greatest security risk to network users. Once communications are air-bound, it is generally not risky (in terms of detection) nor expensive for an intruder to intercept messages. The technical sophistication required to capture and interpret such transmissions is not great, and the cost can be as low as several hundred dollars for intercepting radio transmissions and several thousand dollars for intercepting satellite communications.

For example, at the 1981 National Computer Conference, Nye spoke at a session on security. He brought with him a Bearcat Scanner, a device that can pick up air-bound communication signals. In front of the audience, he turned on the small box and touched the 'telephone' scan button. We were all able to hear some interesting 'personal and private' mobile telephone conversations during that demonstration. Nye thus made it quite clear just how easy it is to intercept air-bound communications.

Transmissions by wire are much the same as by radio wave, as far as the technical sophistication required of the intrusion equipment and its operator are concerned. However, the intrusion can be detected with the proper equipment. Also, gaining access to the telephone line can present difficulties and risk for the intruder.

With the rising costs of travel and commuting, we suspect that tele-conferencing, tele-commuting, and tele-communications in general will indeed be used to communicate more and more personal, company-confidential, and 'proprietary' information. As use and reliance on such public and private networks increase, so does the need for security on these networks. This leads us to consider the prime method of protection—encryption.

Characteristics of encryption systems

Encryption means applying an algorithm to a message in order to modify, and thus hide, its contents. Four aspects should be considered before deciding to use encryption. (1) The level or degree of technical sophistication of security depends upon the value of the information transmitted and the effort necessary to penetrate the system. (2) The added duties of users for encrypting and decrypting messages must be simple, especially if frequent use of the security system is desired. (3) The strength of the security system should not depend upon the secrecy of the encryption algorithm. And (4) efficiency and security of transmission should not depend upon the message's information content.

Most users of encryption devices have no way to judge the strength of an encryption algorithm. For this reason, we recommend that private encryption methods be approached with caution. Two other encryption methods—the Data Encryption Standard (DES) and the public key systems—are considered by many security experts to present the most viable encryption alternatives; and we agree, because they have fared well under intensive public scrutiny.

The DES algorithm was developed by IBM and offered to the government, as we described in the December 1978 issue. The viability and protection provided by this algorithm has been under public analysis for some time. The algorithm has stood up under this scrutiny very well indeed, regardless of some critical opinions appearing in the trade press. The DES system utilizes a 64-bit code, of which 8 bits are used for validity checking—to specify to the algorithm details about correcting transmission errors—and 56 bits are used as both the encryption and decryption key. The huge difficulty involved in an unauthorized intruder studying an encoded message or group of messages, and then determining the key, is the strength of this system. Therefore, the key is secret but the algorithm is publicly available.

The debate about DES has centered on the 56-bit key—that it should be longer and that someday (maybe) means will be found to break it. But this is conjecture. No one claims that DES can be broken today or in the reasonable future.

In public key systems, instead of one key being used for both encryption and decryption, a different key is used for each process. A party's public key is just that—public—and can be obtained from a public file by any sender to encrypt a message to be sent to that party. But only that party's *private* key can be used to decrypt the message. In the reverse direction, the two keys play just the opposite roles. The two keys are thus complementary.

An alternate methodology to encryption is scrambling. Scrambling involves altering the wave pattern of a transmission. Scrambling does offer some protection, but not much. At best, it may discourage casual listeners, says Nye. So scrambled systems should not be considered as very secure. And yet, the tele-conferencing services we are familiar with generally rely on scrambling as their means of protection—if they provide any security measures at all (and many do not).

This brings up the question of providing security for wide bandwidth communications, such as those needed for audio-graphic and video conferencing. We recently came across two products that perhaps provide a glimpse of the future. Both Racal-Milgo of Miami, Florida, and Linkabit of San Diego, California, demonstrated interesting encryption devices at the Tele-Communications Association Conference late last year. Both systems use the DES algorithm. The Racal-Milgo unit encrypts/decrypts at rates up to 9600 bps; the Linkabit device can operate at rates up to 6.5 mbps. These new products demonstrate that work is being done in this important area of security.

A major problem, Nye explained to us, is that encryption units are stand-alone and can cost as much as \$20,000 each. Protecting just one high speed data channel can cost as much as \$40,000. Built-in units would be far less expensive, he feels, but there has not been enough user concern in this area to prompt manufacturers to include such features, he told us.

We see tele-communications impacting both business travel and commuting in the future. These new forms of communication are differ-

ent—very different—from what most people are used to. Before companies rush into installing tele-conferencing rooms and work-at-home options, we suggest learning as much about the subjects as possible, because very little is yet known about their consequences.

We will address the subject of tele-commuting, and the problems associated with managing 'remote' employees, in more depth in a near-future issue.

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